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ARTICLE

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Illness perceptions and health-related quality of life in individuals with overweight and obesity

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INTRODUCTION: To understand how individuals (self-)manage obesity, insight is needed into how patients perceive their condition and how this perception translates into health outcomes (e.g., health-related quality of life, HRQOL). Our objectives were (1) to examine illness perceptions in individuals with overweight and obesity, and (2) to investigate associations of these perceptions with physical and mental HRQOL.

METHODS: In a cross-sectional analysis of the Netherlands Epidemiology of Obesity Study ($n = 6432$; 52% women), illness perceptions were assessed using the Brief Illness Perception Questionnaire, and HRQOL was assessed using the 36-Item Short-Form Health Survey. Illness perceptions were calculated for different categories of overall, abdominal, and metabolically unhealthy obesity. We investigated associations of illness perceptions with HRQOL using BMI-stratified multivariable linear regression analyses.

RESULTS: Compared to individuals with normal weight, individuals with obesity believed to a higher extent that their condition had more serious consequences [Mean Difference (95%CI): 1.8 (1.6–2.0)], persisted for a longer time [3.4 (3.2–3.6)], manifested in more symptoms [3.8 (3.6–4.0)], caused more worry [4.2 (3.9–4.4)] and emotional distress [2.0 (1.8–2.2)], but was more manageable with medical treatment [3.1 (2.9–3.4)]. They perceived to a lesser extent that they had personal control [−2.2 (−2.4, −2.0)] and understanding [−0.3 (−0.5, −0.1)] regarding their condition. These negative perceptions were less pronounced in individuals with abdominal obesity. Behaviour/Lifestyle was attributed by 73% of participants to be the cause of their obesity. Stronger negative illness perceptions were associated with impaired HRQOL, particularly the physical component.

CONCLUSION: Individuals with obesity perceived their conditions as threatening, and this seemed somewhat stronger in individuals with overall obesity than those with abdominal obesity. Behaviour/Lifestyle is a crucial target intervention and empowering self-management behaviour to achieve a healthy body weight may deliver promising results. In addition, strategies that aim to change negative perceptions of obesity into more adaptive ones may improve HRQOL.

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INTRODUCTION

Obesity is a global epidemic. In 2016, the World Health Organization (WHO) reported that more than 650 million adults have obesity, which is triple the prevalence of 1975 [1]. The rapidly increasing prevalence of obesity, and the consequent decrease in health-related quality of life (HRQOL) of individuals with obesity [2–6], reveals an urgent need for a sustainable (self) management of obesity in addition to or in the context of (dietary/nutritional) public health policy and regulations.

To assist patients with obesity (self) manage their condition effectively, it is important to understand the thinking process that motivates behaviour in individuals with obesity. The Common Sense Model provides a framework to understand the dynamic processes, which entails how an individual interprets and responds to stimuli signalling health threats [7–10]. The model proposes that when individuals face a health threat, they are stimulated to create 'illness perceptions', which are cognitions ('ideas') and emotions ('feelings') that are constructed simultaneously, and that motivate them to choose/exhibit a particular coping behaviour to address the threat. This behaviour then results in an illness outcome which patients constantly reappraise, and the outcome appraisal may lead to adjustments in how patients perceive their condition and the way they cope with the condition. The reappraisals create a cyclical and iterative feedback mechanism loop of illness perceptions → coping → outcomes, until the desired outcomes are reached [7–10]. This mechanism is particularly important for chronic conditions, such as obesity, when treatment takes a long time and constant evaluation of action is needed [Supplementary Fig. 1] [Supplementary Table 1].

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The effect of illness perceptions on both behavioural and medical outcomes has been shown in various conditions [11–13]. Studies have shown that stronger negative illness perceptions are associated with worse outcomes, whereas positive perceptions with better outcomes [14]. For example, in post-myocardial infarction patients who underwent cardiac rehabilitation, stronger positive perceptions were associated with better physical therapy/rehabilitation attendance and faster resumption to work (*behavioural outcomes*) [14, 15]. In patients with type 2 diabetes, stronger negative perceptions are associated with suboptimal glycaemic control (higher glycosylated haemoglobin type A1c, or HbA1c), whereas positive perceptions, such as *personal control*, relate with more optimal glycaemic control (lower HbA1c) (*medical outcomes*) [13, 16, 17]. In relation to HRQOL as one of the most important outcomes that influence daily life functioning, studies in chronic conditions such as chronic obstructive pulmonary disease, chronic kidney disease, and type 2 diabetes, also show that negative illness perceptions were associated with impaired HRQOL, whereas more positive perceptions were associated with a better HRQOL [18–22].

Identifying (negative) illness perceptions is crucial, as it creates opportunities to improve patient's self-management and health outcomes [12]. Illness perceptions are modifiable, and modifying unhelpful/maladaptive illness perceptions may improve individuals' coping behaviours towards the illness and subsequently its outcomes [14]. For example, in a systematic review of studies in individuals with type 2 diabetes, improvement in illness perceptions after interventions result in better glycaemic control, or lower HbA1c, after three to six months post-intervention, albeit only a small to moderate effect sizes [23]. The Interventions involve behaviour change techniques, such as goal setting, providing information, action planning, problem-solving, and strengthening social support [23].

Given the importance and modifiability of illness perceptions, as shown in other chronic conditions [14, 23], it becomes apparent that identifying (unhelpful) illness perceptions in individuals with obesity may also potentially play an integral role in improving the (self) management. However, obesity is a complex condition and different criteria exist to define obesity. Although body mass index (BMI) is commonly used to define *overall obesity*, BMI possesses limitations as it neither distinguishes between body fat and lean body mass, nor gives information on body fat distribution [24]. To overcome these limitations, the definition of *abdominal obesity* may be used to detect excess intra-abdominal (visceral) fat deposition, which has been established to be a strong risk factor for type 2 diabetes and cardiovascular diseases [25, 26]. In addition, as the complications of obesity may manifest to a different degree between individuals (i.e., an individual with obesity may have no cardio-metabolic abnormalities, while another individual may have multiple obesity-related diseases), the definition of *metabolically unhealthy obesity* is used to define the combination of obesity and the metabolic syndrome [27–30]. Illness perceptions are dynamic and may vary between conditions, or between stages/phases within the same condition [31–35]. However, whether individuals within these different groups of obesity perceive their condition differently is not yet explored.

To date, there is limited literature on illness perceptions of individuals with obesity, with previous studies being conducted in relatively small samples and only used BMI categorisation to define obesity [Supplementary Table 2] [36–44]. Also, although many studies had observed that HRQOL was impaired in individuals with obesity [2–6], whether illness perceptions contributed to the impairment is not yet known, and thus, studying this relation can provide opportunities to improve HRQOL in obesity.

Therefore, in the present study, we aimed [1] to identify illness perceptions in individuals with obesity, as categorised by multiple definitions of obesity, and [2] to investigate whether these perceptions are associated with physical and mental HRQOL in BMI groups.

METHODS

Study design and population

This study is a cross-sectional analysis of the baseline measurements of the Netherlands Epidemiology of Obesity (NEO) study, a population-based prospective cohort study. The study is conducted in Leiden (in the west of the Netherlands) and includes 6671 individuals aged 45–65 years, with an oversampling of individuals with overweight or obesity. The study includes a reference group of individuals with normal BMI distribution ($n = 1671$) from Leiderdorp, a neighbouring municipality. Recruitment was done via local advertisements and invitation letters sent by general practitioners to their patients aged 45–65 years in Leiden and its surroundings. Men and women aged 45–65 years were invited to participate if they had a self-reported BMI of >27 kg/m^2. To account for this oversampling of individuals with overweight, all residents 45–65 years of the municipality Leiderdorp were invited to participate irrespective of their BMI. The majority (95%) of the population are White-Caucasian. Between 2008 and 2012, baseline measurements of the NEO study were performed at the Leiden University Medical Centre (LUMC), the Netherlands. The study was approved by the medical ethics committee of the LUMC and all participants gave written informed consent [45].

All participants were invited to visit the NEO study centre after an overnight fast. Before this study visit, participants completed a questionnaire at home with items examining demographic, lifestyle, and clinical characteristics. At the study centre, all participants underwent an extensive physical examination, including anthropometry, blood sampling, and imaging. A subset of the study population ($n = 2580$) was additionally randomly selected to undergo MRI examination to measure the intra-abdominal visceral adipose tissue. Detailed information about the study design and data collection has been described in a previous publication [45]. For this study, we excluded participants ($n = 239$) with missing data on illness perceptions ($n = 139$), BMI, total body fat ($n = 31$), waist circumference ($n = 8$), and metabolic syndrome components ($n = 61$), which resulted in a total number of 6432 individuals in our analyses.

Assessment of Illness Perceptions

We assessed illness perceptions using the Brief Illness Perception Questionnaire (BIPQ) [14, 15]. BIPQ is a validated measure that is widely used across populations with different age categories, illness types, countries, and languages. It has a strong concurrent, predictive, and discriminant validity, and sensitivity to change. Compared with other illness perceptions measures, it also has the advantage of its brevity and low participant burden, thus suitable in studies with large sample sizes [14] [Supplementary Table 3]. BIPQ assesses the domains of cognitive and emotional perceptions that are conceptualised in the Common Sense Model, which are the *consequence* of the condition on biopsychosocial functioning, the expected *timeline* or duration of the condition, the extent to which the patients believe their behaviour and treatment can manage their condition (*personal* and *treatment control*), the symptoms/*identity* of their condition, the degree of illness-related *concern*, *coherence* (understanding), and *emotional response*, and the personal idea of the *cause* of their condition [14, 15].

BIPQ consists of nine items (eight scale-score items and one open-ended item), in which each domain of illness perceptions is represented by one item. All illness perception domains, except the causal domain (item 9), are rated using a Likert scale ranging from 0 to 10, in which higher scores indicate stronger perceptions. Some of the items have a reverse scoring, so that a higher score may represent either a strong positive or strong negative perception. More specifically, high scores on the *consequence* (item 1), *timeline* (item 2), *identity* (item 5), *concern* (item 6), and *emotional representation* (item 8) domains represent more negative beliefs, whereas high scores on the *personal control* (item 3), *treatment control* (item 4), and *coherence* (item 7) domains represent more positive beliefs. Unlike other domains in BIPQ, causal attributions (item 9) are assessed with an open-ended question, in which individuals are asked to list the three most important factors they believe to cause their condition [14, 15]. Responses are then calculated and grouped into general themes, such as psychological attributions, behaviour/lifestyle, biological, chance/accident, and others [46].

For this study, we used the validated Dutch-translated version of the questionnaire adapted for persons with overweight/obesity. According to

Table 1. BMI-stratified descriptive characteristics of the study population ($n = 6{,}432$).

	Normal weight (BMI < 25.0 kg/m^2) $n = 718$ (11%)	Overweight (BMI 25.0–29.9 kg/m^2) $n = 2800$ (44%)	Obesity (BMI > 30.0 kg/m^2) $n = 2914$ (45%)
Age (years)	55.5 (6.1)	55.9 (5.9)	55.7 (6.0)
Men (%)	34	56	43
High education (%)	55	41	30
BMI (kg/m^2)	22.7 (1.6)	28.0 (1.3)	34.0 (4.0)
Total body fat (%)	27.9 (7.3)	32.9 (7.6)	40.8 (7.5)
Waist circumference (cm)	81.9 (8.2)	98.3 (7.8)	110.5 (10.9)
Visceral adipose tissue (cm^2)[a]	57.3 (35.5)	111.5 (49.7)	153.0 (63.6)
Alcohol consumption (g/day)	9.5 (3.2-20.9)	11.2 (3.1-23.4)	7.7 (1.0-20.9)
Current smoker (%)	15	18	16
Metabolic syndrome (%)[b]	10	42	68
Abdominal obesity (%)[c]	6	65	98
Hypertension (%)[d]	52	68	79
Hyperglycaemia (%)[e]	18	39	53
Hypertriglyceridemia (%)[f]	12	35	45
Low HDL-cholesterol (%)[g]	12	29	43

Categorical variables were presented as (%), whereas continuous variables as mean (SD) or median (25th–75th percentiles). The distribution of the continuous variables was checked by examining the histograms. Normally distributed variables were presented as mean (SD), whereas alcohol consumption was presented as median (25th, 75th percentiles) because of its right-skewed distribution.
BMI body mass index, *HDL* high-density lipoprotein, *MRI* magnetic resonance imaging, *BP* blood pressure.
[a]Analysis was conducted in a subset of participants who had undergone abdominal MRI measurements (n = 2498).
[b]Metabolic Syndrome is the co-occurrence of at least three out of five cardiometabolic abnormalities.
[c]Abdominal obesity: Waist circumference above ethnic-specific cut-off (>102 cm in European men and >88 cm in European women).
[d]Hypertension: Systolic BP >130 and/or diastolic BP >85 mmHg OR use of anti-hypertensive agent(s).
[e]Hyperglycaemia: fasting glucose >5.6 mmol/L OR use of a glucose-lowering agent(s).
[f]Hypertriglyceridemia: triglyceride >1.7 mmol/L OR use of a lipid-lowering agent(s).
[g]Low HDL-Cholesterol: <1.0 mmol/L in men or <1.3 mmol/L in women OR use of medication(s) for reduced HDL.

the instruction of use in the original BIPQ paper, we replaced the term 'illness' in the questionnaire with 'overweight'. As the reference population had normal BMI distribution, and thus also included individuals with normal body weight, we modified the term from 'overweight' to '(over) weight' in the BIPQ for this subpopulation. The validated, Dutch-translated version of the questionnaire is available at the original website of the Illness Perceptions Questionnaire: https://ipq.h.uib.no/pdf/B-IPQ-Dutch.pdf.

Assessment of HRQOL

HRQOL was assessed with the validated 36-Item Short-Form Health Survey (SF-36) (version 1.0, RAND Corp.) [47]. SF-36 is a set of generic, coherent, and easily administered questions to assess HRQOL and is widely utilised for routine monitoring of care outcomes in adult patients. The instrument examines eight health concepts which are aggregated into physical and mental composite summary scores. The physical component summary (PCS) consists of four domains (physical functioning, physical role functioning, bodily pain, and general health), whereas the mental component summary (MCS) consists of four other domains (vitality, social role functioning, emotional role functioning, and mental health). The scoring of items in SF-36 is done by transforming the items into domains ranging from 0 to 100, with higher scores represent higher levels of HRQOL. The composite summary scores are based on weighted calculations of all domains [48], with different weights (relative contributions) for each domain according to the population norm [49]. SF-36 can be accessed at https://www.rand.org/health-care/surveys_tools/mos/36-item-short-form.html.

Definitions of obesity

We used the WHO classifications of BMI (< 25.0 kg/m^2 for normal weight, 25.0–29.9 kg/m^2 for overweight, ≥30.0 kg/m^2 for obesity) and total body fat (>25% in men, >32% in women) to define *overall obesity* [50, 51], and classifications by waist circumference (>102 cm in men, >88 cm in women) and intra-abdominal visceral fat (>110 cm^2) to define *abdominal obesity* [52–54]. In addition, to define *metabolically unhealthy overweight/obesity,* we categorised individuals with BMI > 25.0 kg/m^2 according to the presence or absence of metabolic syndrome, which is the co-occurrence of at least three out of five cardiometabolic abnormalities [55]. This definition of metabolically unhealthy overweight/obesity was used to distinguish between those with obesity but without the metabolic syndrome and those with obesity and the metabolic syndrome, who may have an increased risk of developing type 2 diabetes and cardiovascular diseases [55].

BMI was calculated by dividing body weight (kg) by the square of height (m^2) [45]. Total body fat (%) was estimated by the Tanita bio-impedance balance (TBF-310, Tanita International Division, UK). Waist circumference was measured halfway between the iliac crest and the lowest rib using a flexible steel tape measure (SECA Model 201, Seca Gmbh Co, Hamburg, Germany). Visceral fat was measured by Magnetic Resonance Imaging (1.5 T MR imaging, Philips Medical Systems) [56].

Blood pressure was obtained by a digital sphygmomanometer at the left arm and upright sitting position (HEM-7200, Omron Healthcare Co, Ltd, Kyoto, Japan). Fasting glucose, serum triglyceride, and high-density lipoprotein (HDL) cholesterol concentrations were determined using standard clinical chemistry methods (Roche Modular P800 Analyzer, Roche Diagnostics, Mannheim, Germany) [45].

Statistical analyses

Demographic and clinical characteristics were presented as mean (SD), median (25th, 75th percentiles), or percentages. These characteristics were presented stratified by BMI categories of normal weight (BMI < 25.0 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2), and obesity (BMI > 30.0 kg/m^2).

To achieve our first objective, mean (SD) scores of the separate illness perception domains were calculated, stratified by the multiple definitions of obesity. To test differences between groups, mean differences with 95% Confidence Intervals (CI) were calculated, with normal-weight individuals as the reference group. To evaluate whether pre-existing cardiometabolic conditions may have influenced illness perceptions in individuals with overweight and obesity, we repeated these analyses excluding those with pre-existing conditions, defined as having at least one treatment of anti-hypertensive, glucose-lowering, or lipid-lowering medications.

Table 2. Mean (SD) Scores of Illness perceptions stratified by the different definitions of obesity, and mean differences (95% CI) compared with the indicated reference group.

		Overall Obesity			Abdominal Obesity				Metabolically Unhealthy Overweight[e]			
		BMI Categorization (kg/m^2)[a]			Excess Total Body Fat[b]		High Waist Circumference[c]		Visceral Obesity[d]		Metabolic Syndrome	
		<25.0	25.0–29.9	≥30	(–)	(+)	(–)	(+)	(–)	(+)	(–)	(+)
		(*n* = 718)	(*n* = 2800)	(*n* = 2914)	(*n* = 828)	(*n* = 5604)	(*n* = 1689)	(*n* = 4743)	(*n* = 1184)	(*n* = 1305)	(*n* = 2558)	(*n* = 3156)
Consequence	Mean (SD)	4.2 (3.0)	4.8 (2.5)	5.9 (2.5)	4.1 (2.9)	5.4 (2.6)	4.3 (2.8)	5.6 (2.5)	5.0 (2.8)	5.1 (2.5)	5.3 (2.6)	5.5 (2.6)
	Difference (95%CI)	Reference	0.6 (0.4–0.8)	1.8 (1.6–2.0)	Reference	1.3 (1.1–1.5)	Reference	1.2 (1.1–1.4)	Reference	0.1 (–0.1, 0.3)	Reference	0.2 (0.1-0.3)
Timeline	Mean (SD)	3.9 (3.4)	5.8 (2.4)	7.3 (2.1)	4.4 (3.2)	6.6 (2.4)	4.8 (3.0)	6.8 (2.2)	5.7 (3.0)	6.6 (2.3)	6.3 (2.5)	6.8 (2.3)
	Difference (95%CI)	Reference	1.9 (1.7–2.1)	3.4 (3.2–3.6)	Reference	2.1 (2.0–2.3)	Reference	2.1 (1.9–2.2)	Reference	1.0 (0.7–1.2)	Reference	0.5 (0.4–0.6)
Personal Control	Mean (SD)	7.3 (2.2)	5.9 (2.0)	5.1 (2.0)	6.9 (2.3)	5.5 (2.1)	6.7 (2.2)	5.3 (2.0)	6.2 (2.2)	5.5 (2.1)	5.7 (2.1)	5.4 (2.1)
	Difference (95%CI)	Reference	–1.3 (–1.5, –1.2)	–2.2 (–2.4, –2.0)	Reference	–1.4 (–1.5, –1.2)	Reference	–1.4 (–1.5, –1.3)	Reference	–0.8 (–0.9, –0.6)	Reference	–0.3 (–0.5, –0.2)
Treatment Control	Mean (SD)	2.1 (2.7)	3.7 (3.0)	5.3 (2.9)	2.8 (2.9)	4.4 (3.1)	2.8 (2.9)	4.7 (3.0)	3.5 (3.0)	4.6 (3.0)	4.1 (3.1)	4.8 (3.0)
	Difference (95%CI)	Reference	1.5 (1.3–1.8)	3.1 (2.9–3.4)	Reference	1.7 (1.5–1.9)	Reference	1.9 (1.8–2.1)	Reference	1.1 (0.8–1.3)	Reference	0.7 (0.5–0.8)
Identity	Mean (SD)	1.1 (1.9)	3.3 (2.6)	4.9 (2.7)	1.8 (2.3)	4.1 (2.8)	2.0 (2.3)	4.4 (2.7)	2.9 (2.8)	4.1 (2.7)	3.7 (2.8)	4.5 (2.7)
	Difference (95%CI)	Reference	2.2 (2.0–2.4)	3.8 (3.6–4.0)	Reference	2.2 (2.0–2.4)	Reference	2.4 (2.2–2.5)	Reference	1.2 (1.0–1.4)	Reference	0.8 (0.7–1.0)
Illness Concern	Mean (SD)	1.9 (2.4)	4.2 (2.6)	6.0 (2.5)	2.7 (2.7)	5.1 (2.8)	2.8 (2.7)	5.5 (2.6)	3.9 (3.0)	5.2 (2.6)	4.7 (2.7)	5.5 (2.7)
	Difference (95%CI)	Reference	2.4 (2.2–2.6)	4.2 (3.9–4.4)	Reference	2.4 (2.2–2.6)	Reference	2.6 (2.5–2.8)	Reference	1.3 (1.1–1.5)	Reference	0.8 (0.6–0.9)
Coherence	Mean (SD)	7.0 (3.1)	6.8 (2.4)	6.7 (2.3)	7.1 (2.9)	6.7 (2.4)	7.0 (2.7)	6.7 (2.3)	6.9 (2.6)	6.7 (2.3)	6.8 (2.3)	6.7 (2.4)
	Difference (95%CI)	Reference	–0.2 (–0.4, –0.1)	–0.3 (–0.5, –0.1)	Reference	–0.3 (–0.5, –0.1)	Reference	–0.2 (–0.4, –0.10)	Reference	–0.1 (–0.3, 0.8)	Reference	–0.1 (–0.3, –0.1)
Emotional Representation	Mean (SD)	2.2 (2.8)	3.0 (2.7)	4.2 (3.0)	2.0 (2.5)	3.6 (2.9)	2.3 (2.6)	3.8 (2.9)	3.2 (2.9)	3.2 (2.7)	3.5 (2.9)	3.7 (2.9)
	Difference (95%CI)	Reference	0.8 (0.5–1.0)	2.0 (1.8–2.2)	Reference	1.6 (1.4–1.8)	Reference	1.5 (1.4–1.7)	Reference	–0.1 (–0.3, 0.2)	Reference	0.2 (0.1–0.4)

Data were presented as mean (SD) and mean differences (95% CI) from the reference (normal-weight). Illness perceptions range from 0 to 10, in which higher scores indicate stronger negative perceptions for *Consequence, Timeline, Identity, Concern*, and *Emotional Representation* domains, but stronger positive perceptions for *Personal Control, Treatment Control*, and *Coherence* domains [15]. (+): comply with the definition of obesity, (–): do not comply with the definition of obesity.

WHO World Health Organization, *BMI* body mass index, *NCEP/ATP-III* National Cholesterol Education Program/Adult Treatment Panel-III, *MRI* magnetic resonance imaging, *HDL* high-density lipoprotein.

[a]Overall obesity based on WHO classification of BMI: normal weight (BMI < 25.0 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2), obesity (BMI > 30.0 kg/m^2) [49].

[b]Overall obesity based on American Council on Exercise categorisation of total body fat (%): >25% in men, >32% in women [50].

[c]Abdominal obesity based on NCEP/ATP-III criteria of waist circumference: >102 cm in European men, >88 cm in European women [51].

[d]Abdominal obesity based on categorisation of intra-abdominal Visceral Adipose Tissue: >110 cm^2 [52, 53]. Analyses were conducted in a subset of participants who had undergone abdominal MRI measurements (*n* = 2489).

[e]Metabolically unhealthy/healthy overweight based on the presence/absence of metabolic syndrome. Metabolic syndrome is defined as the co-occurrence of at least three out of five cardiometabolic abnormalities (*abdominal obesity, hypertension, hyperglycaemia, hypertriglyceridemia*, and *low HDL-cholesterol*) [54]. Analyses were conducted in a subset of participants with a BMI of ≥25.0 kg/m^2 (BMI-defined overweight and obesity; *n* = 5714).

For the causal domain of illness perceptions, the open-ended responses were grouped into primary domains of *accident/chance*, *behaviour/lifestyle*, *biological*, *psychological*, and *other*; each with detailed subdomains to show the diversity of the responses. Individuals with normal weight were excluded in the causal attribution analysis, and we stratified the percentage (%) of causal attributions domains by overweight and obesity category to examine the difference between the two groups.

For our second objective, we calculated the mean (SD) scores of the HRQOL domains, as well as the PCS and MCS scores, stratified by BMI categories. We performed BMI-stratified multivariable linear regression analyses to examine the associations of the separate illness perception domains with HRQOL PCS and MCS, adjusted for age, sex, education, pre-existing cardiovascular disease, diabetes, and current mental health status. To investigate whether the associations would differ between individuals with normal weight and overweight/obesity, we tested the interactions of illness perception domains with BMI, associated with HRQOL PCS and MCS scores, by including product terms with BMI into the models, categorised into BMI < 25.0 and ≥25.0 kg/m^2. All statistical analyses were performed using STATA Statistical Software (StataCorp, College Station, TX, USA), version 16.

RESULTS

Descriptive characteristics of the study population

After exclusions for missing data on total body fat ($n = 31$), waist circumference ($n = 8$), metabolic syndrome components ($n = 61$), and illness perception domains (n = 138), 6432 participants were included in the analyses. Table 1 presents the characteristics of the study population, stratified by BMI categories. The proportion of overweight was higher in men (56%) than in women (44%), whereas the proportion of obesity was higher in women (57%) than in men (43%). Participants with obesity were more likely to be less educated. Smoking and alcohol consumption were more common in individuals with overweight than those with obesity or normal weight. The proportions of abdominal obesity were 6% in the normal-weight group, 65% in the overweight group, and 98% in the obesity group. Forty-two percent of the individuals in the overweight and 68% in the obesity groups had metabolic syndrome.

Illness perceptions in individuals with overweight and obesity

Table 2 displays the mean (SD) scores of BIPQ domains according to the multiple definitions of obesity [Supplementary Fig. 2]. Compared with those with normal weight, individuals with overweight and obesity perceived their condition to have more serious consequences and persist for a longer duration. They experienced less personal control, but perceived stronger treatment control. They experienced more symptoms/complaints and had more concerns/worries related to their condition. They had less understanding regarding their condition, and they perceived their condition to be more emotionally burdening. These negative perceptions were present in all definitions of obesity, but more pronounced in individuals with *overall obesity* than those with *abdominal obesity*. In the *metabolically unhealthy overweight* categorisation, we observed that individuals with the metabolic syndrome had more maladaptive perceptions (i.e., higher *consequence, timeline, identity, concern*, and *emotional representation*, but less *personal control*) than those without metabolic syndrome, although the mean differences between groups were relatively small.

After excluding participants with treatment for pre-existing conditions, the negative illness perceptions in the overweight and obesity groups remained, although somewhat less pronounced [Supplementary Table 4 and 5].

Causal attributions of obesity

The detailed domains and subdomains of causal attributions of obesity are presented in Table 3. Behaviour/lifestyle factors were perceived as the primary cause of obesity, being reported by the two-thirds majority of the population (77% in overweight and 67% in obesity groups). More than half of those were related to diet/eating habits (e.g., excessive dietary intake, wrong choices of foods).

Other than the modifiable behaviour/lifestyle factors, individuals with obesity were more likely to report non-modifiable or fixed causes, such as biological (15% vs 10%) and psychological (11% vs 6%) attributions, compared to those with overweight.

Illness perceptions in relation to health-related quality of life

Supplementary Table 6 shows the mean (SD) HRQOL scores in the study population, stratified by BMI categories. Individuals with overweight and obesity had less favourable physical HRQOL (i.e., lower scores in all domains and PCS) than those with normal weight. However, mental HRQOL did not differ between individuals with overweight and normal-weight, particularly in the *mental health* and *emotional role functioning* domains, although their HRQOL scores were still more favourable than HRQOL scores in individuals with obesity.

Table 4 presents the regression coefficients for the associations between the separate illness perceptions domains and HRQOL PCS and MCS scores in individuals with obesity, overweight, and normal weight. Stronger negative illness perceptions (i.e., higher *consequence*, *timeline, identity, concern*, and *emotional representation*) were associated with less favourable physical and mental HRQOL. Although the associations were present in all three groups, the associations were stronger in the overweight and obese groups than the normal weight group. The majority of interactions between BMI and illness perceptions domains were statistically significant, particularly in association with MCS, suggesting effect modification by BMI. The p-values of the interactions between the illness perception domains with BMI, associated with HRQOL PCS and MCS, were shown in Supplementary Table 7.

Adjustment for potential confounding by age, sex, education, pre-existing cardio-metabolic diseases, diabetes, and current mental health status attenuated the associations between illness perceptions and HRQOL, particularly for the mental component. Additional adjustment for BMI further attenuated the associations, albeit marginally.

DISCUSSION

In this study, we investigated illness perceptions in individuals with obesity, as categorised by multiple definitions of obesity. In addition, associations of these perceptions with physical and mental HRQOL were studied. Whereas individuals in all groups of obesity perceived their condition as threatening, as reflected by stronger negative perceptions than those without obesity, individuals with abdominal obesity perceived less threat than those with overall obesity. Compared to those without obesity, HRQOL was more impaired in individuals with obesity, and stronger negative illness perceptions were associated with this impaired HRQOL. In the majority of individuals, behaviour/lifestyle was attributed as the leading cause of their obesity.

Studies from Bonsaksen et al. [38–40] observed that, compared to normal-weight participants with COPD, participants with morbid obesity perceived stronger maladaptive perceptions (i.e., longer duration, more serious consequence and worries, stronger emotional reactions, and less personal control), although these perceptions improved over time after attending a course on initiating and maintaining healthy lifestyle choices [39]. The negative perceptions of obesity were consistent with our observations in a general population, although our study adds to the literature that the negative perceptions may vary among different definitions of obesity [36–44].

A previous study in 421 individuals aged >18 years with obesity (BMI > 30) shows that genetic/biological attributions were common, being reported by 86% of women and 60% of men [37].

Table 3. Causal attributions of obesity (calculated in individuals with overweight and obesity, excluding those with normal weight; $n = 5714$).

Main category	Domain	Subdomain	% Domain^	% Subdomain[a]
Accident or Chance	Accident or Injury		0.2	0.2
	Alcohol		7.9	7.9
Behaviour/Lifestyle		Eat at irregular times (e.g., late or skipped meal)	43.7	1.9
		Eating out		0.3
		Extra eating in the evening		1.2
		I consume little fruit, vegetable, or water		0.3
		I eat too much / I have a big appetite		18.1
	Diet/Eating Habits	I have a healthy diet		0.7
		My (or my partner) cooking hobby		0.2
		Social eating (e.g., eating with friends)		0.4
		Tasty foods (e.g., sweets, snacks, soft drinks, etc.)		9.8
		My unhealthy diet/bad choice of food		3.8
		Snacking in-between meals		7.0
	Physical Activity	I am physically active / I exercise routinely	17.3	1.5
		Lack of physical activity		15.8
	Smoking	I smoke	1.6	0.1
		I quit smoking		1.5
	Work	Being unemployed or retired	2.5	0.5
		Long working hours or irregular shifts		0.5
		Type of job (e.g., requires a lot of sitting, work in the catering industry, etc.)		1.5
Biological	Aging		13.1	2.6
	Disease/Medical Condition			3.3
	Hereditary			4.7
	Lack of sleep			0.2
	Pregnancy/Childbirth			0.4
	Treatment/Medication Use			1.9
Psychological	Emotional Eating (e.g., eating when sad, frustrated, or angry)		8.4	2.1
	Family Problems			0.4
	I do not feel good with myself (i.e., low self-esteem)			0.2
	I feel good about myself			0.1
	I feel sad, lonely, frustrated, or depressed			1.3
	I have no motivation			0.2
	Low self-care (e.g., not taking time for myself)			0.1
	My mental state			0.5
	No discipline/self-control			1.1
	Stress/Worry			2.4
Other	Unable to say no		5.6	0.2
	Failed weight loss attempts			0.5
	Holiday/Festivities/Social Occasions (e.g., party)			0.8
	I am not overweight			0.1
	I do nothing / I don't care			0.2
	I do not know			0.5
	I watch my weight			0.2
	My lifestyle (e.g., I enjoy my life, my Burgundian lifestyle, etc.)			1.8
	Throwing away food is a sin			0.1
	Uncategorised			1.2
		TOTAL		100

[a]Percentages from the total perceived causal response.

Another study in 75 individuals aged 18–65 with overweight/obesity (BMI > 25) shows that psychosocial attributions were frequent, as reported by 33% of participants [43]. However, our study observed that these two attributions were far less common than behaviour/lifestyle as the dominant perceived causes of obesity. The different inclusion of BMI, the smaller sample sizes, and the younger population in the previous studies may partially explain the distinct observations. Differences in the instruments used to evaluate illness perceptions may also explain the disparities in causal attributions between studies, as the two previous studies used IPQ-Revised and *Patiententheoriefragebogen*, unlike BIPQ as used in our study [37, 43]. We, however, encourage the use of BIPQ to assess causal attributions of obesity using an open-ended question, as we were able to capture the broader spectrum of responses that arose from the patients, rather than just a pre-specified list of perceived causes. Moreover, as we categorised the causal responses by BMI categories, our study adds to the literature that compared to those with lower BMI (overweight), individuals with higher BMI (obesity) were more likely to perceive maladaptive attributions as the causes responsible for their condition, such as fixed psychological problems and non-modifiable family genetic/hereditary.

Our findings were consistent with previous studies in HRQOL of individuals with obesity, which observed that the impairment of HRQOL was worse with a greater degree of obesity, and more pronounced in physical HRQOL than mental HRQOL [2–6]. As none of the previous studies in illness perceptions of obesity also investigated the associations of these perceptions with HRQOL [36–44], our study adds to the literature by showing that negative illness perceptions were associated with an impaired HRQOL, and more positive perceptions with a better HRQOL. These associations were similar with other populations with chronic conditions, such as chronic obstructive pulmonary diseases, chronic kidney diseases, and type 2 diabetes [18–22]. In almost all domains of illness perceptions, we also observed that the associations became stronger with increasing BMI.

The strength of our study is the large study population, which enabled us to conduct several subgroup analyses and generalise our results to the broader population. However, some limitations of this study should be mentioned. First, due to the observational and cross-sectional nature of the study, there is a possibility of residual confounding, and no causality can be concluded from this study. Second, the unavailability of longitudinal illness perceptions and HRQOL measurements in the NEO study also hinders us from determining whether the negative illness perceptions and the impaired HRQOL in individuals with obesity persist or change over time. Third, although associations were present between illness perceptions and HRQOL, the estimates of the associations are relatively small, and we are not yet able to conclude whether these levels of estimates translate into observable and meaningful clinical impairment in obesity. Fourth, the age inclusion of this study (45–65 years) may lessen the generalizability of our results to the total adult population. Nevertheless, the large number of participants within our population age range warrants the extrapolation of the study findings for the middle-aged population, who are at increased risk of obesity-related complications [57], as well as a common age range targeted for interventions in modifying illness perceptions [23]. Fifth, as the majority of our population is White-Caucasian, this may limit the external validity of our study for other ethnicities.

Research implications

First, as we identified negative illness perceptions in individuals with obesity, there is a further need for psychosocial intervention studies that aim to change these negative perceptions into more positive ones. Future longitudinal (intervention) studies may also want to investigate whether changing illness perceptions and the associated HRQOL translate into improved clinical outcomes (e.g., weight loss) in individuals with obesity.

Second, although we used multiple criteria to define obesity [50–55], we observed that BMI categorisation yielded stronger contrast in illness perceptions between groups, and it enabled us to observe the illness perceptions becoming gradually more negative as the BMI increases. Thus, we recommend future behavioural research to use BMI-categorisation to define obesity, as it might be more relevant when illness perceptions (and possibly other patient-reported outcomes) are assessed.

Third, future studies in this field are also encouraged to recruit a broader age range of population, as well as individuals with a more diverse ethnic background when possible, to ensure broader generalizability for the global adult population.

Clinical and public health implications

Our study sheds light on the potential clinical relevance of illness perceptions in individuals with obesity. First, despite the more detrimental health effects of abdominal obesity [25, 26], individuals with abdominal obesity perceived their condition somewhat less threatening than those with overall obesity. This finding suggests that the meaning of 'abdominal obesity' is not always well-perceived by the general public. Despite being commonly discussed in medical fields, 'abdominal obesity' may not translate into a tangible, perceptible phenomenon for the average person. When unmeasured and undiscussed, patients may not be aware that they have abdominal obesity and the health risks that pertain to it. This less awareness of abdominal obesity may impose a serious health problem, as patients may be less inclined to take an adaptive response if they do not perceive the threat. Therefore, raising public awareness of abdominal obesity and its adverse outcomes is important. This can be done, for example, by means of interventions on modifying illness perceptions that have been shown to associate with better health outcomes [23, 58], and by routine measurement of waist circumference in daily clinical practice to screen for the presence of abdominal obesity, while also providing more information to the patients about the impact of abdominal obesity. Besides these efforts, public policy related to body weight management should be enhanced, such as those related to the availability of foods and creating facilities that encourage the public to be physically active, as health behaviour is determined to a great extent by societal norms [59]. When in contact with individuals with obesity, we emphasise that physicians and policymakers to not 'blame' or stigmatise the patient, as it discourages these individuals from seeking healthcare support and can even harm their psychological and emotional wellbeing [60].

Second, our study contributes in refining potential interventions addressing obesity and weight management. As we observed a strong *treatment control* belief in individuals with obesity, this implies that (medical) treatment might be favoured as the patients believed it could control their condition. In addition, as the majority of individuals with obesity reported behavioural causal attributions, this implies an ample opportunity for healthcare professionals to offer lifestyle modification programs that aim to achieve healthy body weight, as those who perceived their behaviour to be the cause of their illness are more likely to accept behavioural interventions [61, 62]. As physical activity has been shown to be effective in helping reducing weight in obesity, preventing the occurrence of obesity-related diseases [63], and slowing the progression of abdominal obesity [64], lifestyle interventions that are offered should also encourage the individuals to be more physically active as a part of the behaviour change. Last, as individuals with a greater degree of obesity reported more psychological and biological/hereditary attributions, these individuals may need specific attention as those who attribute fixed or non-modifiable causes tend to have less control about their condition and experience more maladaptive outcomes (e.g., distress) [10].

Table 4. The associations of illness perceptions domains with health-related quality of life components in the total study population ($n = 6432$).

		Physical HRQOL (PCS)			Mental HRQOL (MCS)		
Illness perceptions		**Normal weight**	**Overweight**	**Obesity**	**Normal weight**	**Overweight**	**Obesity**
Consequence	Crude	−0.18 (−0.36, 0.01)	−0.52 (−0.65, −0.40)	−1.06 (−1.21, −0.92)	−0.20 (−0.40, 0.01)	−0.73 (−0.86, −0.60)	−1.17 (−1.32, −1.03)
	Adjusted	−0.12 (−0.30, 0.07)	−0.16 (-0.29, -0.04)	−0.53 (−0.67, −0.38)	0.10 (−0.06, 0.26)	−0.04 (−0.14, 0.06)	−0.09 (−0.21, 0.03)
Timeline	Crude	−0.35 (−0.52, −0.19)	−0.19 (-0.32, −0.05)	−0.41 (−0.59, −0.24)	0.01 (−0.18, 0.19)	−0.30 (−0.44, −0.16)	−0.21 (−0.39, −0.03)
	Adjusted	−0.32 (-0.48, −0.16)	0.01 (−0.12, 0.13)	−0.16 (−0.33, 0.01)	0.12 (−0.02, 0.26)	0.03 (−0.08, 0.13)	0.10 (−0.03, 0.23)
Personal Control	Crude	0.44 (0.18, 0.69)	0.49 (0.32, 0.65)	0.34 (0.16, 0.52)	0.04 (−0.24, 0.32)	0.48 (0.31, 0.65)	0.54 (0.35, 0.72)
	Adjusted	0.39 (0.14, 0.64)	0.17 (0.02, 0.32)	0.04 (−0.13, 0.21)	−0.06 (−0.27, 0.15)	0.02 (−0.10, 0.15)	0.04 (−0.09, 0.17)
Treatment Control	Crude	−0.40 (−0.62, −0.19)	−0.33 (-0.44, −0.22)	−0.48 (−0.60, −0.35)	−0.05 (−0.28, 0.19)	−0.33 (−0.45, −0.22)	−0.52 (−0.65, −0.39)
	Adjusted	−0.33 (−0.54, −0.12)	−0.15 (-0.26, −0.05)	−0.20 (−0.32, −0.09)	0.16 (−0.02, 0.34)	0.05 (−0.03, 0.14)	−0.03 (−0.12, 0.07)
Identity	Crude	−1.24 (−1.52, −0.95)	−1.12 (-1.24, −1.00)	−1.67 (−1.80, −1.55)	−0.51 (–0.83, −0.18)	−0.83 (−0.95, −0.70)	−0.96 (−1.09, −0.82)
	Adjusted	−1.06 (−1.36, −0.76)	−0.80 (-0.92, −0.68)	−1.26 (−1.39, −1.13)	0.33 (0.07, 0.59)	0.04 (−0.06, 0.14)	0.22 (0.11, 0.33)
Illness Concern	Crude	−0.77 (−1.00, −0.54)	−0.62 (−0.74, −0.49)	−1.00 (−1.14, −0.86)	−0.31 (−0.57, −0.06)	−0.72 (−0.84, −0.59)	−1.00 (−1.15, −0.86)
	Adjusted	−0.65 (−0.88, −0.42)	−0.32 (−0.44, −0.20)	−0.55 (−0.69, −0.41)	0.26 (0.06, 0.46)	0.01 (−0.10, 0.10)	0.01 (−0.11, 0.11)
Coherence	Crude	0.01 (−0.17, 0.20)	0.05 (−0.08, 0.19)	−0.04 (−0.20, 0.12)	−0.04 (−0.25, 0.16)	0.13 (−0.01, 0.27)	−0.09 (−0.25, 0.07)
	Adjusted	−0.01 (−0.20, 0.17)	−0.09 (−0.22, 0.04)	−0.04 (−0.19, 0.10)	−0.05 (−0.21, 0.10)	0.12 (0.01, 0.22)	0.01 (−0.11, 0.12)
Emotional Representation	Crude	−0.23 (−0.44, −0.02)	−0.58 (−0.70, −0.46)	−0.78 (−0.90, −0.66)	−0.63 (−0.85, −0.41)	−1.11 (−1.23, −0.99)	−1.45 (−1.56, −1.33)
	Adjusted	−0.07 (−0.28, 0.15)	−0.09 (−0.22, 0.04)	−0.14 (−0.27, −0.01)	−0.06 (−0.24, 0.12)	−0.22 (−0.33, −0.12)	−0.36 (−0.46, −0.26)

Data were presented as regression coefficients (β) with a 95% Confidence Interval (CI). Multivariable models were adjusted for age, sex, education, pre-existing cardiometabolic diseases, diabetes, and current mental health status. Interpretation, for example: in overweight individuals, after adjusting for confounding factors, a one-point increase in consequence perception domain score is associated with a decrease of PCS score by 0.16 point. *HRQOL* health-related quality of life, *PCS* physical component summary, *MCS* mental component summary.

CONCLUSIONS

Whereas individuals in all groups of obesity perceived their condition to be threatening [15], the negative illness perceptions of those with abdominal obesity were less pronounced. These negative perceptions in individuals with obesity were associated with impaired HRQOL. Behaviour/lifestyle is the most dominant causal attribution of obesity and may become a crucial target intervention.

Raising public awareness on (the impact of) abdominal obesity, empowering self-management behaviour to achieve healthy body weight, as well as implementing strategies to modify unhelpful perceptions of obesity into more positive ones, may improve health outcomes in individuals with obesity including HRQOL.

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AUTHOR CONTRIBUTIONS

FSS, RdM, YM and AAK conceived and designed the study. HJL performed the imaging examinations. FSS, RdM, YM, and AAK performed data analysis and interpretation. FSS and AAK searched the background literature. FSS wrote the first draft with insightful contributions from RdM, YM, HJL, and AAK. All authors contributed to the revision of the reviewed and approved the final version of the paper.

COMPETING INTERESTS

The authors declare no competing interests.

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